A BEHAVIOURAL STUDY COMPARING THE EFFECTS OF 2D AND 3D ON HOLISTIC AND FEATURAL FACE PROCESSING

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Introduction

Recognition of faces occurs via holistic processing, whereas inverted faces are processed by their individual features [1]. This is attributed to upright faces retaining intact first-order information – the configuration of individual features in a prototypical representation (e.g. eyes above nose). This structure is typically disrupted in inverted faces where the positions of individual features no longer match the cognitive face template [2]. However, these findings are based on studies using 2-dimensional (2D) faces. We tested whether these results could be extended to more realistic stimuli, particularly 3-dimensional (3D) faces possessing greater visual depth. Participants completed a match-to-sample face recognition test consisting of upright and inverted faces that were presented in both 2D and 3D. Due to 3D providing greater visual information in the z-axis that is absent in 2D, 3D faces therefore more closely resemble real-life perceptions of faces that our recognition systems are attuned to, compared to 2D faces. Based on this premise, **it is postulated that 3D faces would be recognised with shorter reaction time (RT) and greater accuracy than 2D faces during holistic and featural processing.**

Key Comparisons	Predictions
2D upright vs. 2D inverted	Faster RT and greater accuracy for upright condition
3D upright vs. 3D inverted	
3D upright vs. 2D upright	Faster RT and greater accuracy for 3D upright condition
3D inverted vs. 2D inverted	Faster RT and greater accuracy for 3D inverted condition

Subjects

- 26 participants (22 to 29 years old; 11 males).
- One female excluded (accuracy below 0.5 in at least one experimental condition)

Stimuli

- 52 male Chinese faces (Southeast Asian ethnicity)
- The presentation of faces was counterbalanced such that all faces appeared an equal number of times as each other in each condition

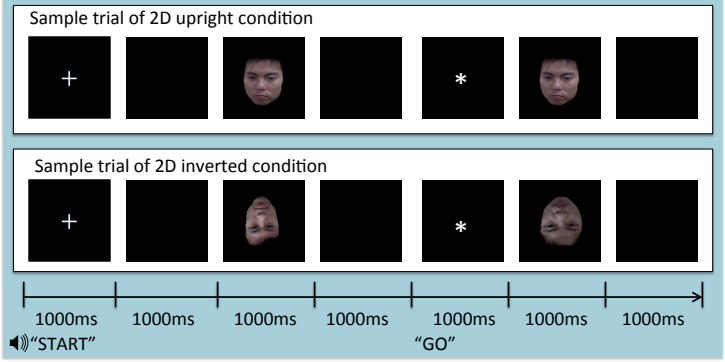
Stimuli Presentation

- Programme written in C++ with OpenGL library to render and display stereo point clouds
- Task administered on Alienware laptop supported by Nvidia 3D Vision™ and operating with refresh rate of 120Hz

- Participants equipped with 3D Vision wireless active shutter glasses (adjusted for so that 2D and 3D may be seen through the glasses)

Task

- Participants made judgments whether the test face is the same as the study face
- 4 blocks of 52 randomised trials; equal number of trials per condition

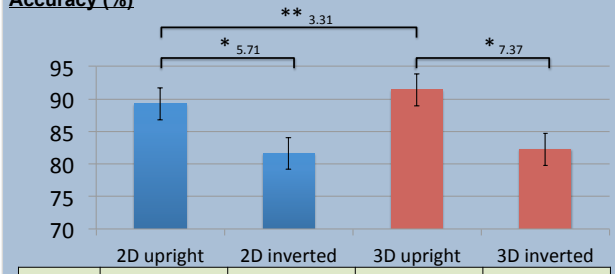


Results

Accuracy and RT of the 4 conditions.

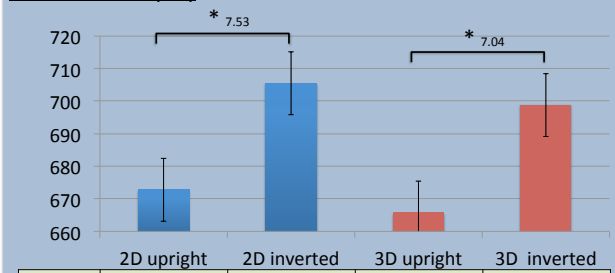
Paired-sample t-tests were performed for the key comparisons, df = 24, *p<.01, **p=.01, significant t-value is reported next to the asterisk.

Accuracy (%)



	2D upright	2D inverted	3D upright	3D inverted
Mean (S.E.)	89.23 (0.84)	81.62 (0.75)	91.38 (0.81)	82.23 (0.80)

Reaction times (ms)



	2D upright	2D inverted	3D upright	3D inverted
Mean (S.E.)	672.78 (12.59)	705.39 (12.28)	665.77 (12.39)	698.83 (12.13)

Conclusion

- Regardless of 2D or 3D, upright faces are recognised with faster RT and greater accuracy than inverted faces. This reinforces that face recognition depends heavily on first-order information, and that holistic processing is more advantageous than featural processing.
- During the recognition of upright faces where there is greater emphasis on holistic processing, 3D faces are recognised with greater accuracy than 2D faces with no difference in RT. These serve as evidence that the additional visual information of 3D do not lead to increased cognitive load but rather, facilitate an increase in efficacy of face recognition mechanisms.
- There is no significant difference in RT or accuracy between 2D and 3D inverted faces. This might be because 3D only enriches the visual details but does not address the disruption of first-order information.

Future Directions

- Neuroimaging techniques to provide insight into the underlying mechanisms that support 2D and 3D face recognition
- Include laterally rotated faces to provide greater external validity
- Explore the effect of 2D and 3D recognition for faces of other races
- Examine if 3D influences RT and accuracy during holistic and featural processing of non-face objects

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[1] Tanaka, J. W. and Farah, M. J. (1993). Parts and wholes in face recognition. *The Quarterly Journal of Experimental Psychology*, *46* (2), 225 – 245. [2] Diamond, R. and Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experiment Psychology: General*, *115* (2), 107 – 117.